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AUTHOR Fortune, Ron
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ABSTRACT

The knowledge and mental processes called on in mathematics can be used to improve composition. Three desirable requirements of an analogy to be used in teaching writing are that it should bridge the art of writing and science, should be readily accessible to the mind of the average student, and should allow the student to employ an architectural faculty to learn about an architectonic skill such as rhetoric. Mathematics offers paradigms that satisfy these requirements. Two categories of analogs can be used: strategic and pictorial. Strategic mathematical paradigms that are applicable to writing instruction include formulas, specific mathematical operations, elementary set theory, and theorem proofs. Pictorial paradigms that can be used for composition instruction include graphs and geometrical designs. The use of mathematical analogies helps students become more aware of writing forms. (TJ)

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Ron Fortune
Ohio State University
Department of English
Columbus, Ohio

MATHEMATICAL ARCHITECTURE AND THE TEACHING OF WRITING

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Given the general approach that has been adopted by many of those who research cross-disciplinary writing, I would like to begin by emphasizing what my approach does and does not entail. Many studies of cross-disciplinary writing try to demonstrate the various ways in which the politics of teaching writing and another subject adjacently can be managed. Or, they focus on the application of the skills taught in the writing half of the course to the assignments required in the other half. However, too often they neglect to explore how the mental processes called on in different disciplines are mutually reflective and how the basic models which express the mental processes endemic to one discipline can be used as tools through which the other can be taught; they too often overlook the possibility of developing paradigms for teaching one discipline by using the paradigms common to another. My concern in this paper will not be with cross-disciplinary writing in the first sense, i.e., as an arrangement in which writing instruction focuses on the demands of some other course that is taught in tandem; rather, my concern will be with cross-disciplinary writing as an enterprise in which the knowledge acquired in a separate discipline is applied to the teaching of composition.

Since I will be discussing the analogical use of what have been traditionally intra-disciplinary paradigms as a means of teaching writing, an appropriate point of departure for my comments is William Irmscher's essay, "Analogy as an Approach to Rhetorical Theory." He begins his

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essay by asserting two premises with which I wholeheartedly agree: first, that rhetoric is an "architectonic art that provides us with theoretical paradigms for understanding complex systems; and, second, that analogy develops the architectural faculty of the human mind, the capacity to see how systems work by plans and models" (350). From these premises, he concludes that "analogy provides us with an appropriate approach to rhetorical theory" (350). The theoretical analog that he explores in the essay is based on Burke's pentad, and the working definition of rhetoric at which he arrives is stated as follows: "Rhetoric is concerned with the interaction, both verbal and nonverbal, of Agent, Purpose, and Audience in terms of the choices made in creating the Act within a particular Scene" (352). He then goes on to explain how this same paradigm applies to activities in disciplines other than rhetoric. Because I am strongly attracted to Irmscher's theory of analogy as an approach to rhetoric, my natural reaction as a teacher of freshman English is to wonder about the practical application of his theory to teaching beginning writers how to write. While his adaptation of the pentad is inappropriate for the freshman English class, other paradigms must be available that would be appropriate as teaching tools in such a context. It seems to me that the most effective analogs in a freshman writing course would meet three basic conditions.

At the conclusion of his essay, Irmscher notes that by cultivating "meaningful analogs," we learn "that our concerns as rhetoricians are not exclusive, but inclusive" (354). And, indeed, at the outset of his essay, he does emphasize the cross-disciplinary value of his adaptation of the pentad. He suggests that it is designed to embrace "certain common denomi-

nators in various arts" and to bridge the "writer, painter, composer, sculptor and architect" (350). However, given the scientific orientation of many of the students enrolled in required writing courses, it would seem more desirable to derive analogs that bridge the art of writing and the sciences. Such analogs would demonstrate more emphatically "that our concerns as rhetoricians are not exclusive, but inclusive" because they would bridge concerns that are too often seen as mutually exclusive.

I also feel that, if an analog is to be a purposeful teaching tool, it must be readily accessible to the mind of the average student in a freshman writing course. If one of analogy's main advantages, in addition to its development of "the architectural faculty of the human mind" (350), is that it uses what the student already knows in order to open up for him what he does not know, then the most purposeful teaching analogs are those that are based on the knowledge that the student brings to the course. To use an analog that would itself be new to the student would in all likelihood complicate unnecessarily a process that is already sufficiently difficult for most freshmen.

A final criterion by which I would measure the instructional value of an analog derives from Irmscher's premises about the inherent natures of rhetoric and analogy. As I noted earlier, he argues that analogy constitutes an appropriate approach to rhetoric because rhetoric is "an architectionic art that provides us with theoretical paradigms for understanding complex systems" and that analogy "develops the architectural faculty of the human mind." Given these statements, it would seem that if one is going to teach writing as an architectonic skill, the best instructional paradigms that he can use are those which are themselves explicitly archi-

tectonic. This strategy would thus have the student employ an architectural faculty to learn about an architectonic skill from the viewpoint of a clearly architectonic paradigm.

Finding paradigms that at once adhere to the basic principles underlying Irmscher's theory of analogy as an approach to rhetoric and satisfy the criteria that I have described is not as difficult a task as it might initially seem to be. We need only consult basic scientific paradigms that exhibit architectural properties common to the mental processes necessary in all disciplines, the arts as well as the sciences. Mathematics seems to me to be the discipline that most readily offers paradigms that satisfy these requirements. That mathematics is integral to all the sciences cannot be doubted; it is, as one mathematician puts it, the "queen and servant of the sciences." If we can discuss writing in terms of mathematical paradigms, we bridge rhetoric and writing not just to mathematics but to all of the scientific disciplines to which those mathematical paradigms are so relevant. Moreover, if these paradigms are sufficiently basic, we can be relatively certain that the student will bring an acquaintance with them to the study of writing, and what they do know can be used to teach them what they do not. Finally, mathematics is a highly architectonic discipline; thus, its paradigms are in all likelihood ideally suited to teaching an architectonic skill, writing, through the exercise of an architectural faculty, analogy.

I have divided the mathematical analogs that I will consider here into two catagories: strategic analogs and pictorial analogs. The first category consists of standard mathematical paradigms (formulas, sets, theorem proofs) whose strategies are closely analogous to rhetorical strategies exercised

at different stages and levels of the writing process. Pictorial analogs (graphs and geometric designs) do not try to match mathematical and rhetorical strategies; rather, they involve the use of mathematical pictures to portray visually rhetorical notions and strategies.

One mathematical paradigm that writing teachers generally try to avoid is the formula. Because we believe that writing is essentially an organic, nonmechanical process, we try to avoid drawing the parallel between the mathematical formula and the well-written essay; we fear the implication that writing can have the predictability of a mathematical formula. But in fact, the mental activity that goes on during the resolution of a mathematical formula parallels the activity involved in the writing act so closely that writing can be conveniently and fruitfully discussed in terms of mathematical formulations.

When understood rightly, the general notion of a formula is as applicable to rhetorical progressions as it is to mathematical progressions. Essentially, in mathematics, a formula describes the path that mathematical units must take when a given function is applied to them. While the units themselves can vary from situation to situation, the function itself remains the same. In rhetoric, too, we prescribe the path that any set of ideas must take for a given purpose. The example of this that immediately comes to mind is the argumentative essay. In most rhetorical texts, we discover that an argument usually consists of five parts: the introduction, the statement of fact, the confirmation, the refutation, and the conclusion. Of course, we understand that the variables involved in the rhetorical formula are less fixed than are those involved in the mathematical formula and that, as a result, the rhetorical formula is more flexible than its

mathematical counterpart. But this does not make the analogy less legitimate, and when Howard Brashers in his book, The Structure of Essays, discusses rhetorical structures in terms of what he calls "normative formulas," the implied analogy gives the student, who is already aware of the dynamics of mathematical formulation, a perspective on an important writing skill that makes that skill more accessible to him.

In addition to the applicability of the general notion of formula to the discussion of rhetorical strategies, I believe that specific mathematical operations can be used to explain to students the nature of certain rhetorical relationships. This is most easily demonstrated with reference to the rhetoric of the sentence. In explaining the relationship among parts in a sentence, we can often use elementary set theory to simplify for students a wide range of syntactic operations. Something as basic as a transition, for example, can be explained as an element common to otherwise mutually exclusive sets. Or, we can use elementary set theory to describe the dynamics of coordination and subordination. When we deal with sentence combining, we often begin with two or more simple sentences that should be combined into a single sentence, often by means of subordination. In teaching subordination, we try to explain to students that, in mathematical terms, the simple sentences amount to units that actually belong to a single set but have been separated into different sets. We note that this separation implies that the units do not share the same governing principle that defines the boundaries of the set. We then try to demonstrate that they do share the same governing principle, the proposed thought, and should as a result be included in the same set. Once we have shown the separate sentences to be parts of a single set, we can emphasize their differences within that set by

getting into the notion of subsets.

The mathematical paradigm that is most directly applicable to teaching the rhetoric of the paragraph is the theorem proof. Essentially, when developing a mathematical proof, the student is required to begin by asserting the proposition he is attempting to prove. From there, he must demonstrate the acceptability of the proposition by showing in a series of closely interconnected steps that it is the logical derivative of already accepted definitions and proven propositions. Finally, it is common in a theorem proof to restate the proposition as proven after the proof has been established. The format of a theorem proof thus goes from a statement of the proposed theorem through a series of logically interconnected supporting theorems and definitions to a restatement of the theorem as proven. We can easily appreciate the applicability of this paradigm to teaching the paragraph, which generally goes from a controlling generalization through a series of logically connected supporting or illustrative examples to a restatement of the paragraph's controlling idea in the form of a conclusion.

The logical procedure of the standard theorem proof is something with which any student who has taken high school math will be well-acquainted. He thus has learned in the mathematics course to fix firmly in his mind the exact idea he expects to prove so that he is aware of its intricacies and takes each one into account as he develops his proof. He has also learned that he must then enlist supporting information that is generally accepted as fact. The mathematical proofs through which the student has learned this procedure are available to the writing instructor on virtually every page of a basic algebra or geometry text, and the instructor who utilizes these resources and begins a discussion of the rhetoric of the paragraph by re-

hearsing a mathematical proof allows the student to begin the learning process at an advanced stage.

So far, I have concentrated on nonpictorial mathematical paradigms, on paradigms that cultivate mathematical thought processes that specifically parallel rhetorical thought processes, but my discussion would be incomplete without an analysis of some of the basic ways in which mathematical pictures can be used to develop paradigms that depict rhetorical notions and strategies. Perhaps the most readily apparent and the most widely used of these is the graph. In a composition textbook (The Complete Stylist and Handbook) that seems to use more mathematical pictures to represent rhetorical activities than do most textbooks, Sheridan Baker uses a graph to explain how the body of a paper should be organized. His graph consists of three vectors: the declining vector represents the path followed by the reader's attention during the course of an essay, the ascending vector portrays the path that should be taken by the writer's appeal, and a third basically horizontal vector suggests the line ideally taken by the reader's interest if the reader's attention vector and the writer's appeal vector are properly balanced. Baker then explains the rhetorical meaning of the graph; he notes that the writer should arrange his points in order of increasing interest because "unfortunately, [the reader's] interest may be relaxing as it becomes satisfied: the reader's normal line of attention is a progressive decline, arching down like a wintry graph. Against this decline the writer must oppose his forces, making each successive point more interesting, so that [the] reader's interest will continue at least on the horizontal, with no sag, and preferably with an upward swing" (36). Baker's cross-disciplinary means of establishing his point makes the writing strategy he recommends

more readily comprehensible for the student because it utilizes what might be termed a mathematically pictorial language which the student has had to use perhaps more extensively, in a formal context anyhow, than the English language. Moreover, it should be emphasized that the mathematical technique that Baker uses to prescribe the proper shape of an essay can be as easily applied to discussions of other rhetorical matters.

Another kind of mathematical picture that can be used to teach writing is the geometric design. This type of paradigm can be and has been used in two different ways by writing teachers. It has been used most widely to represent visually the overall shape of an entire essay or of one of its parts. Two common complementary examples are the upright and inverted triangles which suggest the respective shapes of the deductive and inductive paragraphs. Just as the apex constitutes the triangle's peak, the topic sentence represents the paragraph's ideological pinnacle; and just as the triangle widens at the base line, the paragraph "widens" where documenting evidence is listed and analyzed. For deduction, represented by the upright triangle, the apex is uppermost, and the widening process takes place as we descend to the base line. For induction, represented by the inverted triangle, the widened baseline is uppermost, and there is a narrowing descension to the apex. In a general sense, these triangles give the student a mathematical visual means of checking whether or not the stops that have been following during the course of the paragraph fulfill the requirements of the strategy.

The second use of the geometric design to teach writing is perhaps more instructional than the first, for it attempts to do more than merely represent the shape of a rhetorical strategy or notion, it tries to

duplicate their dynamics. One particularly good example of this is given in Edward P. J. Corbett's discussion of the syllogism; therein, he uses a square of opposition to differentiate the four kinds of categorical propositions and to delineate their interrelationships. Each corner of the square represents one kind of proposition with contradictory propositions opposed diagonally, contrary propositions opposed horizontally, and subalternant propositions differentiated vertically. The ideological interrelationships of these propositions are suggested by their geometric placements on the square: the subalternant propositions share the same x-axis, contrary propositions share the same y-axis, and contradictory propositions have no axis in common. Corbett's geometric paradigm nicely demonstrates how the dynamic of a relatively complex rhetorical notion can be expressed in cross-disciplinary terms that make the notion more readily available to the student.

Throughout my preparation of this presentation, I have been aware of a possible objection that might be raised against the approach to teaching writing that I have recommended here; that is, some might contend that this approach would foster an undue concern with form at the expense of content. To this, I would only answer that, for most students, form is a means of discovering content, and it is a mistake to assume that, for them, an emphasis on form is restrictive to the point of being counterproductive.

That the focus of this paper has been restricted to the analogical bridging of writing and mathematics should not be read as meaning that I regard other disciplines as necessarily less helpful in the development of instructive analogical paradigms for the art of writing. I believe, with Dryden, that "all is of a piece throughout," that whatever and however

we learn in one context will have an important bearing on our attempts to learn in another. So, from here, I expect to continue my investigation into disciplines other than mathematics for appropriate analogs that will help me make learning to write a more manageable task for my students.

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